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# Delivering a new undergraduate module in Asset Management

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## Abstract

In 2014 the authors presented a paper on the design of a new undergraduate module in Asset Management (AM) as a final year option on a Masters in Engineering (MEng) programme. They undertook to report in 2015 on how the new module was delivered including any challenges, the results, and the students' feedback on its introduction. This paper describes the module's delivery and outcomes. It highlights some of the opportunities for both engagement and improvement of undergraduate teaching of key asset management topics. The paper includes the main lessons learned that need to be factored into undergraduate teaching and engagement in the field of asset management.

## 1 Introduction

At the Asset Management Conference 2014 the authors presented the methodology and experience gained in designing a new 10 credit MEng module, known as a Unit, at a major university [1]. The Unit is targeted at addressing the multidisciplinary needs, at national and international levels, that are identified in the management of physical assets through their life cycle. The Unit's primary goal is to "develop students seeking employment in national and international organisations at the front line of making important investment decisions, procuring, designing, constructing or managing physical assets. They therefore need to have an understanding of the requirements of the emergent AM discipline." Also "a key principle behind the design of the Unit, and its delivery, is the engagement from the outset with industry and government experts in AM. The Unit's design ensured that their input occurs at important stages throughout the delivery cycle."

### 1.1 The Technical Environment

In 2014 the asset management body of knowledge underwent extensive changes and improvements with: the introduction of ISO55000 [2]; the updating of the Institute of Asset Management's (IAM) Anatomy [3]; the re-alignment of the International Infrastructure Management Manual to ISO55000 [4]; the full introduction of the IAM's Self-Assessment Methodology (SAM) [5], the revisions to the GFMAM's Asset Management Landscape [6], and their Assessor Specification [7], and the roll out of the Professional

Certificate and Diploma examinations in asset management by the IAM. The Institute of Public Works Engineering Australasia launched its Professional Certificate in Asset Management Planning in April 2014 [8], complementing the New Zealand Asset Management Support group's National Diploma in Infrastructure Asset Management [9]. This creates a highly dynamic environment in which to design and implement a new undergraduate module. The five key challenges were:

1. *Engagement.* Make asset management a stimulating subject for students with commensurate levels of engagement. This encapsulated planning what could be effectively covered in 5 months, given the wide range of topics available.
2. *Scope.* Ensure what was taught was consistent with the latest asset management body of knowledge. This included working with leading industry practitioners to explain about the world of asset management activities. This also involved using best practice templates for the students to be able to compare two major infrastructure asset management plans from the UK public sector.
3. *Technology.* Design new material for undergraduates using modern accessible technologies.
4. *Feedback.* Effectively test the knowledge transmitted and captured using a combination of lectures, research, reading, reporting, modelling and examination.
5. *Testing.* Trial and use an advanced computer testing tool for the final examination that could ensure a fair method of individual testing and subject coverage. This required balancing the challenges of a new form of exam against the assessment needs of a Level 7 qualification.

## 2 Preparation Cycle for Delivery

The preparation cycle to introduce a new Unit is typically 12 months at a Higher Education institution when the credits available have a significant impact on potential student outcomes. This time allows for the Unit's demand and needs assessment, the outlining of content, the approval process, timetabling, internal marketing of the option to prospective student and sign up. Planning for the Unit began in late 2013, its scope was approved by Faculty in January 2014, student recruitment began in late summer 2014 and timetabling in September 2014 for delivery between January and June 2015.

### 2.1 Level of Investment

In the authors' experience, preparation from first principles for a new topic at a major University typically has a ratio of

10 to 1 between design and material preparation, checking and approval up to the teaching delivery. Hence a one hour lecture takes about 10 hours of preparation, with 13 double lecture periods representing about 260 hours of design. Marking of the Unit's new coursework, exam design and setting, approval by the External Examiner, invigilation and marking for the Unit represents around 140 hours in addition to the planning work. This represents an investment of 400 hours for the front line team of designers and lecturers. External industry experts also agreed to deliver specific and specialised topics within the required body of knowledge to be covered.

Key support from the administration team, setting up computer based systems, creating new electronic and physical workspace and setting up the computer based examination was about 100 hours for the Unit.

Of this 500 hours total, 55% to 60% was spent in the set up stages between January and September 2014. This front end loading ensured that the students had sufficient introductory materials to begin signing up to the Unit in September 2014.

The cut-off date for sign up was the start of January 2015. There was some internal movement of students between final term options in the first week. Eventually 46 students successfully completed the Unit in June 2015. This represents around 50% of the final year MEng Civil Engineering cohort at the University, which is a high percentage for a new Unit, highlighting asset management's popularity.

### 3 Rising to the Five Key Challenges

Dealing effectively with the five key challenges set out in Section 1.1 proved to be important in the successful delivery of the Unit. Section 3 explains how this was done.

#### 3.1 Engagement

Four students provided input into the design of the Unit. They helped select the key topics that the cohort wanted to learn about. Their popular topics needed careful blending with the knowledge required to meet the Unit's Intended Learning Outcomes (ILOs) described in the authors' 2014 paper.

There was a 5 month teaching and testing window, including a 'mock' exam, revision and the finals in early June 2015. The last month in the semester was dedicated to group work submission and exams. This left 13 double lectures in which the teaching and visiting expert team needed to cover a range of relevant and interesting topics as agreed with the students.

This approach created a stimulating mix of content. The lectures by expert practitioners and researchers helped bring some complex topics to life. The students asked a range of relevant and challenging questions to these experts demonstrating a high level of engagement.

Week	Subject	Lecturer, Organisation
1	A practitioners introduction to asset management  Unit design and programme	C Lloyd, CAS and IAM  A Crossley, Bristol
2	<i>Heathrow Airport 24/7</i>  Creating and sustaining an asset management culture	P Burcombe, Heathrow Airport  S Male, Bristol
3	<i>Water Works</i> - the industry's approach to asset management	M Greetham, Bristol
4	<i>Keeping The Lights On</i> - National Grid's approach to asset management  <i>Lifecycle Management</i> - The challenges of creation and disposal of major Assets.	D Dunkley, National Grid  S Male, Bristol
5	Asset Management Information Systems	A Crossley, Bristol
6	Using the SAM tool (Computer lab session 1)	A Crossley, Bristol
7	<i>Bridging the Gap</i> – Asset deterioration and failure modes  <i>Bridge Management</i> – Practical challenges	M Kashani, Bristol  S Luke, Jacobs
8	<i>Water Water Everywhere</i> – flooding, resilience and asset management  Financial and business impact of good and poor asset planning and management (Network Rail/London Underground)	S Male, Bristol  A Crossley, Bristol
9	Open house Q&A on assignment and approach to 'mock exams'	A Crossley, Bristol
10	'Mock exam' (Computer lab session 2)	A Crossley, Bristol
11	<i>Systems, Resilient Cities &amp; The Built Environment</i>  Risks in managing assets	S Passmore, TEST  S Male, Bristol
12	Asset investment decision making	A Crossley, Bristol
13	Exam planning and Unit summary + Q&A	A Crossley, Bristol

Table 1: The new Asset Management Unit's 2015 Teaching Schedule.

### 3.2 Scope

Table 1 sets out the topics selected for the first year of delivery. Each lecture had preparatory reading from the Unit's set texts. Preparatory reading was aligned with the lectures. It was typically taken from Lloyd [10], Lloyd's Case Studies [11], relevant AM standards, publications from the IAM and international sources.

Care was needed to ensure alignment with the latest asset management body of knowledge. Numerous new publications and collateral emerged during the design stage. This meant that the Unit's material needed regular review to ensure its currency for the first half of 2015. Time was spent reviewing and cross mapping the Unit to the IAM's competencies as highlighted in Table 1 of the authors' Asset Management Conference 2014 paper. Ultimately, the key aspects of asset management commensurate with a Level 7 Unit were covered in the available time. This was a combined planning and implementation challenge but it was successfully achieved.

### 3.3 Technology

As befits a major institution the use of technology to enable a content rich experience is expected by the students as part of the full learning experience. The following six examples illustrate the use of advanced/mobile technology for the Unit:

1. *Blackboard*. This e-portal is used for planning, communication and dissemination of the Unit's materials. It allows all users to tailor their degree of access including instant notifications when new material is added to the learning space such as: announcements, articles, lecture slides and notes, relevant videos and video links, interim assessments, together with a high quality interactive support forum for the raising and responding to questions. The Blackboard support forum is especially useful as it is a searchable database by topic, key word and response ranking. The forum allows real time dialogue between all parties. Students are also encouraged to support each other with relevant references and advice in this moderated environment. This is set up for mobile access using the iOS and Android platforms.
2. *BSOL*. All students have access to British Standards Online to ensure they have the latest asset management and related standards. This is a searchable resource and standards are made available in PDF format for marking up and searching. As with Blackboard the BSOL is available via mobile technology from the 'My Bristol' student portal.
3. *ICE Virtual Library*. The set texts by Lloyd were made available to the participants as on-line resources to either read or download by relevant chapter. As the case studies within the reading list and used for class discussions were all potential topics for the final examination, the ability to download and annotate the material was a real advantage to the students. Typical access was via tablets and laptops.

4. *IAM website*. Some material referenced in the Unit's lectures was available via the site [www.theIAM.org](http://www.theIAM.org) for the students to use using IAM guest or registered affiliate access. The excellent videos hosted on the site were very useful and the Anatomy v2 was well regarded as a concise supplement to the Units taught material. Students were all encouraged to consider joining the IAM either as student members or NXTGen members on graduation. The IAM home page was a Unit link from Blackboard.
5. *Self-Assessment Methodology (SAM)*. Students were taught about the IAM's SAM tool in class and computer labs. The SAM tool was then used to carry out in-depth comparative analysis of two major asset owners' asset management plans. The asset owners were drawn from different sectors. Given the students' speed of learning and their capability at using the tool, they gave some valuable insight on the usability and complexity of SAM. Section 3.4 has more information on their viewpoints.
6. *QuestionMark Perception (QMP)*. QMP was used to practice for a mock examination with instant grading and explanatory responses. The mock was set up in exam conditions. QMP was then used in the final examination as explained in Section 3.5.

### 3.4 Feedback

On reviewing the Unit, the students said they appreciated the input and commitment of time from the visiting speakers. They recommended this be reinforced with a site visit to see a major asset related activity for the Unit's delivery in 2016.

The students fed back concerns over the volume of material they were expected to read and prepare for the next lecture. This was expected to take approximately an hour a week before the next lecture. The students explained that the preparatory work was taking closer to two hours. This was too much, given the large amount of work in the final year of the MEng programme. The students recommended that pre-reading be limited to one article, chapter or video so that they could be fully prepared to respond in the lecture setting. This was valuable feedback to the Unit's designers and will be implemented in future years.

The students all used the SAM tool, starting with an explanatory lecture then a computer workshop the following day. They individually completed sample SAM questions. The students then came together in their assignment groups to create their SAM analysis based on the two Asset Management Plans (AMPs) they were researching: Transport Scotland's Road Asset Management Plan (RAMP) and Network Rail's Asset Management Plan (and policies).

Student feedback on SAM was mixed. A lot of the students considered there to be potentially too many questions and sub-questions with a degree of overlap. Whilst an external Asset Management Auditor may find the nuances of SAM intelligible, the students thought that the average interviewee would have difficulty in fully understanding and engaging with the Auditor.

The students have a high standard of English as required by the University on entry. Therefore, a key recommendation from this highly educated, multi-lingual cohort was for the SAM designers to adopt a simpler, more concise and mutually exclusive set of assessment statements.

They also thought that if the interviewee was not fully fluent in English and an experienced Asset Management professional, the resultant SAM marking was likely to be more variable than desired. The consensus was that the questions within SAM were highly finessed and not readily translated to an international user base. The students therefore recommended that the complexity of the question set be addressed before onwards translation into other languages.

The students' viewpoints were not unique, they reflected what one of the authors heard from some senior international asset managers at a round table session on SAM at the Asset Management Conference 2014. This also means that future translation of SAM into other languages requires bilingual and highly experienced Asset Managers. 'Simple is best' was the recommended approach from the student cohort. This would also assist ISO55001 system design and audits.

### 3.5 Testing methodology for the Examinations

After considerable assessment and quality assurance testing, QuestionMark Perception was chosen as the final examination tool for the Unit.

Designing and testing the QMP question bank was a highly detailed and thorough process. The department's External Examiner was very interested in its use in a final examination. Adopting this route entailed far more preparation time in setting the examination in January 2015 with extensive quality assurance processes adopted both internally and externally. The process started with a question set built in MS Word. Each of the authors then checked all the questions. The exam paper was then reviewed internally for accuracy and intelligibility prior to sending to the External Examiner for final approval.

The External Examiner's initial feedback highlighted that the approach was innovative for a final MEng examination and therefore the marking system needed careful design to ensure guesswork on responses was not rewarded. The team considered whether to use negative marking for incorrect responses. However, when this had been trialled for testing in second and third year professional studies management Units some students had expressed concern over what they had termed a potential for too many 'shades of grey' on some responses giving inappropriate penalty marking. The Unit design team therefore decided to use variable scoring for more complex comprehension and scenario type questions with full marks for a 'perfect' answer and around 50% marks for the next closest answer - a near miss. No marks were awarded for the three remaining responses. This approach was verified as effective in the mock exam.

Exams are managed in a highly invigilated environment as required by the University's codes and regulations. This meant that a special 'closed' computer laboratory was needed for the final exam with no external access to web sites, memory sticks or mobile technology.

All students had to use their individual university usernames and passwords to sign in. The QMP technology automatically timed them out at 2 hours or 2.5 hours for those students registered as requiring additional time. The technology also tracked progress during the exam by 'greying' out completed responses on a summary table. This enables students to return to incomplete questions at a later time in the exam, for efficiency.

The balance of the range and complexity of questions and the time planning proved effective. Of the 46 students sitting the exam, less than 10 completed the exam and left before the final 15 minute deadline. The students requiring extra time made full use of it.

The results were automatically processed by the QuestionMark system then exported into a database for checking. The scores for each question and the time taken for the paper by each student was available within 30 minutes of completing the exam. All the students passed the exam with marks ranging from low 50s to high 80s expressed as percentages. This saved the examiners about 60 hours of marking and cut out the potential for any errors in scoring papers. It also gave consistency in marking.

## 4 Initial Benchmarking Assessment of the Unit

Zuashkiani et al [12] presented a paper at the Asset Management Conference 2014 setting out their interim findings from a review of asset management curricula developed from 36 undergraduate and postgraduate programmes dealing directly with or related to the AM discipline. They acknowledged that asset management is multi-disciplinary. They consequently critiqued the 36 programmes' curricula against the IAM's Asset Management Anatomy and Competences Framework [13], both of which incorporated the GFMAM's Asset Management Landscape. The seven observational topic areas they made from the results of this analysis, and marked below in italics, have been benchmarked against the new Unit's curriculum.

In terms of *Asset Management as a qualification* the Unit is positioned as a final year option within the Department of Civil Engineering's MEng programmes and is not a stand-alone qualification. It represents 10 credits within the 480 credit four year MEng degree in Civil Engineering accredited by the Joint Board of Moderators (JMB). The Unit has been specifically designed with a substantive cross-sector industrial and government focus, drawing on the authors' expertise in asset management from government and industry, both nationally and internationally.

Coverage of the GFMAM *Asset Management Landscape and the 39* subjects is a challenging area. However, in broad terms the module has been designed to cover *the six high-level topic based subject areas* of Strategy & Planning, AM Decision-Making, Life-Cycle Delivery, Asset Information, Organisation and People, and Risk & Review through the interaction of the seminars / lectures; team-based comparative analysis of two cross-sectoral AMPs for large scale asset owners; the examination; and the required reading, of which ISO 55000 and the IAM's Anatomy are pre-requisites supported by the Lloyd texts. Additionally, the majority of the student case study teams adopted the headings from ISO 55001 Asset Management: Management Systems Requirements as their analytical template for AMP analysis supported by the SAM tool; whilst others used a variant of this, typically a hybrid between the standard and other AMP templates they had reviewed.

The emphasis on *soft vs hard* subject groups covered by the Unit had to be set within the context of the option module sitting within a predominately 'hard' Civil Engineering MEng programme. Whilst there are other 'soft' management related subjects within this programme, the Unit's designers deliberately chose to incorporate 'soft' topics within the curriculum, for example the seminar on creating an asset management culture in lecture week 2. Equally, the authors and external guest lecturers addressed the concept and practical consequences of the concept of 'organisation' within their own seminars. The case study analysis and critique also required student teams to address the 'soft' areas of AM. Finally, some topics, such as Resilient Cities and the concept of Resilience within Asset Management addressed both 'hard' and 'soft' issues and challenges.

In terms of *popular subjects* it would be fair to say that based on the take up of the module, with 46 candidates completing the Unit, this proved a very popular final year option. Student involvement in design together with its multi-disciplinary and multi-sector focus proved attractive. A four year MEng in Civil Engineering accredited by the JBM should have a combination of compulsory and option subjects, usually with a greater emphasis on options at years 3 and 4.

The converse of the above *unpopular subjects* raised an interesting question for the positioning of the module in the UoB MEng programme. In terms of the unpopular subjects raised by Zuashkiani et al, they noted that subjects such as organisational culture and people related issues are given little attention in most asset management related courses probably due to the courses being located in engineering departments. The Units approach to 'soft' versus 'hard' topics has been addressed. There is no doubt the Unit was seen as a challenging option by some of the students. The authors acknowledge that the requirements of accreditation places considerable emphasis on 'hard' engineering subjects. Notwithstanding the analysis and the observation made by Zuashkiani et al on unpopular subjects, UK MEng programmes in Civil Engineering place considerable attention on team-work via group exercises, case study and joint design

project work. Therefore, to effectively balance the Unit's focus, attention to organisation, culture and people related topics was deliberately designed into the curriculum.

In terms of the final observation from Zuashkiani et al, namely, *competence development*, there is no doubt that the students were exposed to a substantive overview of AM. An MEng degree is characterised by its need for breadth and depth of knowledge and understanding. Breadth in the Unit was covered by the seminars, reading material and examination. Depth was covered via the team-based case study work. An element of training also took place with comparative dissection of the two real life AMPs, supported by the use of the SAM tool. In terms of the AM profiles noted in Part 2 of the IAM Competency Framework, there is no doubt that students taking the Unit received a considerable boost towards achieving the role profile set out for an AM new entrant – a graduate with two years training.

## 5 Conclusions

The new Asset Management Unit required innovative approaches to delivery including:

1. Designing and delivering a curriculum which provided a sense of the breadth of asset management and also permitting candidates to delve into its deeper aspects through team-based comparative analytical work on two AMPs.
2. Working with four volunteers from the student body to plan engaging content and topic coverage, with the students acting as end users/customers using ISO 9001 principles.
3. Getting the buy-in and support of busy asset management practitioners and thought leaders.
4. Designing, populating and accessing high quality digital learning systems compatible with mobile technologies.
5. Students interviewing asset management leaders about their policies and practices.
6. Gaining the approval of Internal and External Examiners for the use of computer examinations at the 'final' degree level examinations.

The primary approach to achieving depth of knowledge was to use team based case study working to analyse, compare and contrast two publicly available asset management plans against international best practice.

The secondary approach was to use an examination to test both the breadth and depth of asset management knowledge at an individual level using questions from the texts, seminars and also scenarios developed from the case study work.

Analysis of the Unit's results concluded that the Intended Learning Outcomes (ILOs) were achieved using a strategy of: extensive reading; industrial experts leading seminar-based discussions; team working on critical evaluation of AMPs; and a computer based exam to test breadth and depth of AM knowledge.



Figure 1: Mr Jonathan Davies receiving the 2015 Bristol Asset Management prize on graduation day.

All the students passed the module; the average grades were higher than anticipated due to the enthusiasm and commitment of the cohort; and some students are planning careers in asset management. A University Asset Management prize was given to the top student taking the Unit based on results. In 2016 this was Mr Jonathan Davies. Figure 1 shows Mr Davies receiving the award.

The students recommended practical enhancements for the 2016 cohort using in-class and online feedback. At the time of writing the initial sign up to the 2016 Unit appears popular. The University will play its part in developing the next generation of young professionals and graduates with an appreciation of the multi-disciplinary skills needed to be successful Asset Managers.

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